

## **Providing Field Support for the Behavior Response Study (BRS-08)**

Diane Elaine Claridge  
Bahamas Marine Mammal Research Organisation  
P.O. Box AB-20714, Marsh Harbour  
Abaco, Bahamas  
phone: (242) 366-4155 fax: (242) 366-4155 email: [Diane.Claridge@bahamaswhales.org](mailto:Diane.Claridge@bahamaswhales.org)

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### **LONG-TERM GOALS**

The long-term goals of this project are to contribute towards the development of a science-based sonar use policy for the US Navy which reduces the risk of injury to beaked whales from mid-frequency sonar. This project will also increase our understanding of the population and behavioral ecology of beaked whales and other cetacean species which occur in the AUTEK-Andros Operating Area in the Tongue of the Ocean, northern Bahamas, and will help to mitigate the effects of naval activities on these populations.

### **OBJECTIVES**

The over-riding objective of this effort was to provide field support for Phase II of the Behavior Response Study which took place in 2008, known as BRS-08. Specific objectives were:

- 1) To work with the Marine Mammal Monitoring (M3R) program at the Atlantic Undersea Test and Evaluation Center (AUTEK) to visually locate cetaceans detected acoustically on the AUTEK range, with a particular focus on finding beaked whales (Family *Ziphiidae*).
- 2) To photo-identify individual animals within each group found.
- 3) To attach digital acoustic tags or Dtags to beaked whales, pilot whales and other species to prepare for playback experiments and to gather baseline data on the diving behavior of these species in Tongue of the Ocean (TOTO).
- 4) To conduct focal follows of the tagged whale(s) before, during and after a playback experiment.
- 5) To conduct aerial surveys for stranded or injured cetaceans before BRS-08 commenced, following each playback (if deemed necessary), and after BRS-08 ended, as part of the BRS mitigation.
- 6) To provide a team from a Bahamian non-governmental organization to allow independent observation of the experiment.

### **APPROACH**

The Behavior Response Study is a large, multi-national project in which responses of whales exposed to underwater sounds are measured to identify and mitigate their adverse effects. The first phase of this project (known as BRS-07) took place during August and September 2007 at the US Navy's AUTEK range in the Bahamas during which playback experiments were successfully conducted on beaked whales and pilot whales. BRS-08 represents Phase II of this project with the primary goals of

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increasing the number of experiments and varying the type of signals used during playbacks, including MFA sonar, killer whale calls and pseudo-random noise.

During BRS-08, the R/V *Roger Revelle* provided the field platform for the scientific team of over 35 people. Bahamas Marine Mammal Research Organization (BMMRO) provided a 23.5-foot (6.8 m) Novurania rigid-hulled inflatable boat (*RHIB*), equipped with 2-115 Hp four-stroke outboard engines, which was stored on the deck of the *Revelle* and used for photo-identification, tagging and focal follows. While the *RHIB* was not the primary tagging vessel, it was used to maximize tagging opportunities.

When weather permitted, the *RHIB* was launched from the *Revelle* at first light in a location where beaked whales were detected acoustically by the M3R team. The number of observers on board the *RHIB* ranged from 6 – 7 but averaged 6 throughout the field effort. Key personnel included Diane Claridge (captain, Bahamas Marine Mammal Research Organization (BMMRO)), Charlotte Dunn (primary photo-id, BMMRO) and Olivia Patterson (data recorder, BMMRO), Dr. Nicola Quick (photo-id and focal follow lead, Sea Mammal Research Unit (SMRU), weeks 1-3) and Dr. Gordon Hastie (photo-id and focal follow lead, SMRU, weeks 4-6). During weeks 1-3, the *RHIB* tagging team consisted of Dr. Ari Friedlander (tagger and photo-id, Duke University), and Mari Quero (data recorder, Woods Hole Oceanographic Institute (WHOI)) and during weeks 4-6, Becky Woodward (tagger and data recorder, WHOI) and Jeremy Winn (photo-id and tag technician, WHOI). Focal follows were conducted by all personnel aboard the vessel.

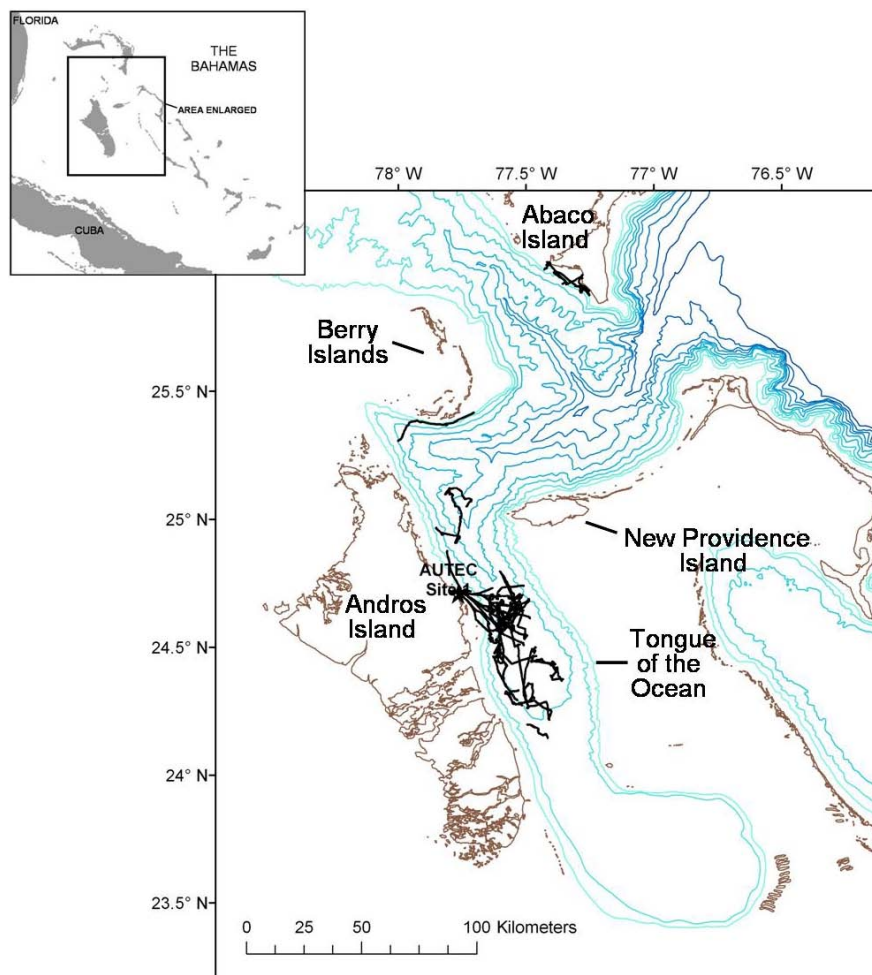
Whales were located using AUTECH's 82-hydrophone fixed array with the M3R acoustic detection program and by visual searches with observers aboard the *Revelle* and the *RHIB*. Once a group was located visually, the *RHIB* made a close approach to obtain high-quality photographs to allow individual identification and assignment of each whale to age and gender classes. Close approaches were also made to attach a Dtag to one or more individuals within the group. For beaked whales, the tagging attempts were made from the tagging boat (an 11-foot inflatable) to limit the possibility of adverse response to the tagging effort, but for other species the *RHIB* carried out tagging attempts whenever opportunities allowed. Focal follows of the tagged whales were conducted from the *RHIB* before, during and after the playback. Focal follow data collection included: focal whale position (range and bearing from *RHIB*), group composition, group cohesion, direction of travel, travel speed and respiration rates, and changes in behavior were noted.

Additionally, BMMRO coordinated and conducted aerial surveys of the coastal areas in search of stranded animals before, during and after BRS tests. Flights were conducted based on differing objectives at the time including pre-BRS and post-BRS surveys, mitigation flights following playbacks and searching for tags. The focus of all flights was to search the shoreline along the eastern coast of Andros Island, but searches also included the small islands in North and Middle Bights, the bank edge and cays along the east side of TOTO, and the coastal areas of New Providence Island.

The Bahamas Marine Mammal Research Organization (BMMRO) is a registered Bahamian not-for-profit organization. As such, BMMRO has served an additional role during BRS as an independent observer group monitoring the experiment. During BRS-08, BMMRO provided 7 personnel working at three different stations: on board the *RHIB*, visual observers on board the *Revelle*, and an acoustic monitor working with the M3R team at AUTECH. Throughout the field effort, BMMRO staff convened to review the observations made by each staff member at their particular station, and any concerns voiced were brought to the attention of the Chief Scientist.

## WORK COMPLETED

During BRS-08, increased winds associated with tropical storms “Gustav” and “Hannah”, and hurricane “Ike” limited the field effort substantially. Nonetheless, the RHIB had 18 days on the water from (23 August – 1 October) tracking 658 nm (1,217 km) (Figure 1), and close approaches were made to 26 groups of cetaceans, including 7 different species. In all, 45.3 hours was spent with animals during encounters conducting photo-identification, focal follows, tagging attempts and radio-tracking of tagged whales.



**Figure 1. Map of the northern Bahamas, including Tongue of the Ocean showing vessel tracks for the RHIB during BRS-08. Most of the effort was centered in middle of the Weapons Ranges but also included northern TOTO and the southwest coast of Abaco Island. The 500m isobaths are shown.**

Information on the groups that were encountered, the number of animals and group size recorded is summarized in Table 1. Close approaches were made most frequently on Blainville’s beaked whales (*Mesoplodon densirostris*), the primary target species. Short-finned pilot whales (*Globicephala macrorhynchus*), a secondary target species, were seen on 4 occasions. Other species encountered included sperm whales (*Physeter macrocephalus*), false killer whales (*Pseudorca crassidens*), melon-headed whales (*Peponocephala electra*), pan-tropical spotted dolphins (*Stenella attenuata*) and Atlantic bottlenose dolphins (*Tursiops truncatus*) which were sighted off southwest Abaco Island.

**Table 1. Summary data for the cetacean groups encountered during BRS-08.**

Species	No. of groups	No. of animals	Mean Group Size (SE, median, mode)	Notes
<i>M. densirostris</i>	13	31	2.4 (0.2, 2, 3)	
<i>P. macrocephalus</i>	1	4	4.0 (n/a)	Resighting of Pm128 from SW Abaco & Berry Is.
<i>G. macrorhynchus</i>	4	89	22.3 (2.8, 25, 25)	Resighted one group 2 times
<i>P. crassidens</i>	2	26	13.0 (0, 13, 13)	Resighted same group
<i>P. electra</i>	1	90	90.0 (n/a)	
<i>S. attenuata</i>	1	10	10.0 (n/a)	
<i>T. truncatus</i>	1	3	3.0 (n/a)	Off SW Abaco Is. Resighting of 3 known individuals

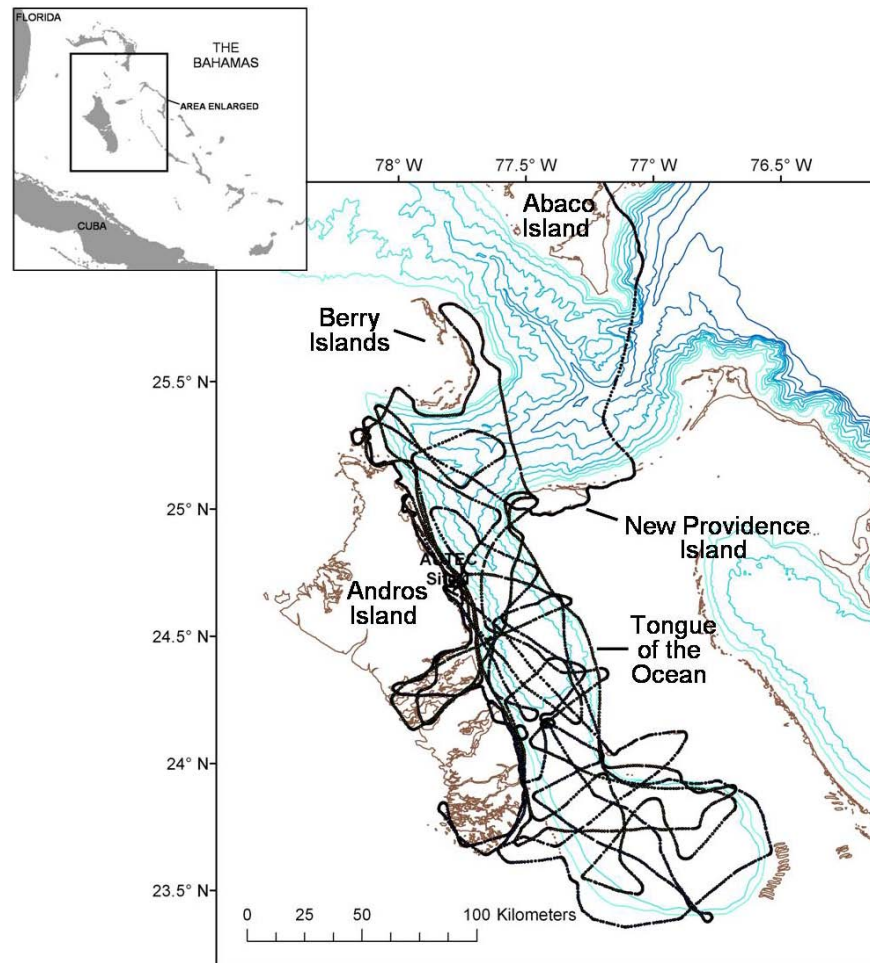
A primary component of the BRS experiment plan involves attaching a Dtag to an animal prior to exposing the whale to the sound source. During BRS-08, Dtags were deployed on one Blainville's beaked whale (a sub-adult male), four short-finned pilot whales (adult males), two false killer whales (adult males) and two melon-headed whales (adults). The pilot whale and false killer whales tags were deployed from the *RHIB*. Two tags came off prematurely and a tag on one pilot whale was never found. Six playback experiments were successfully carried out on 4 different species.



**Figure 2. False killer whale with Dtag being placed on the dorsal fin.**

Five aerial surveys were flown during BRS-08, totaling 19.8 hours of flight time and covering 2,624 nm (4,854 km) during the period. The primary aircraft used included was an Aerocommander, but an Islander was used for the final flight. All flights were flown at an altitude of 500 feet and at an average speed of 100 knots, except during some of the flights made to search for the lost Dtag which climbed

to an altitude of 2,000 feet at times and up to 140 knots. The flight tracks from the aerial surveys are shown in Figure 3. One flight was made before the BRS experiment commenced to search the coastal areas for strandings. There were 3 flights made to search for the lost Dtag which also served as post-exposure mitigation flights. There was a final flight made at the end of the BRS field season. Cetacean species sighted during the aerial surveys included Atlantic bottlenose dolphins and sperm whales, and no stranded or injured animals were found. Sightings of sharks, sea turtles and rays were also recorded during flights.

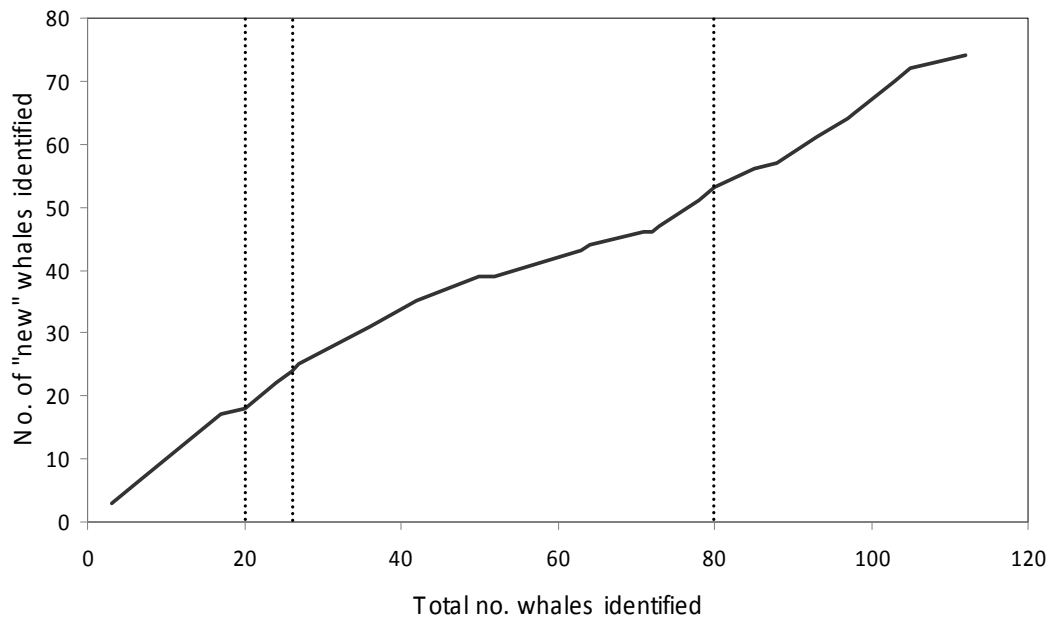


**Figure 3.** Map of the northern Bahamas, including Tongue of the Ocean showing tracks from the aerial surveys flown during BRS-08. The areas surveyed included the east and southwest coast of Andros Island, the channels (Bights) through the middle of Andros, Tongue of the Ocean, and the coasts of the Berry Islands and New Providence Island. The 500m isobaths are shown.

## RESULTS

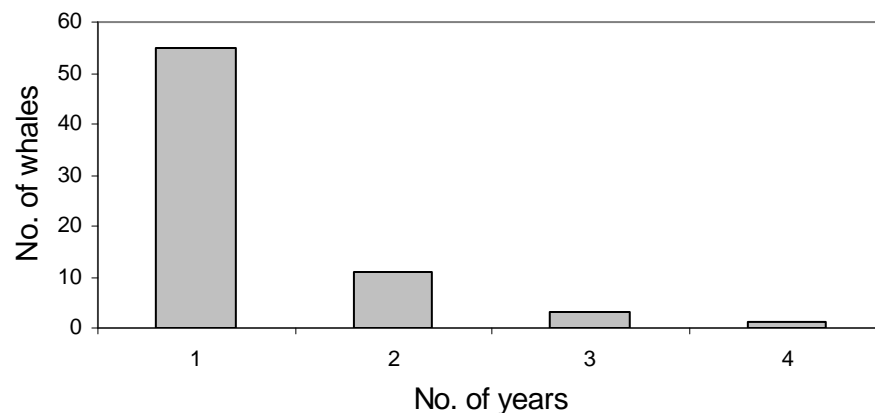
During BRS-08, there were 253 animals seen and approached for photo-identification, tagging and focal follow purposes. Photographic data were collected during 13 encounters with *M. densirostris* (31 whales). A total of 27 individuals were identified, including 10 resightings from previous years. The rate of discovery graph (Figure 4) shows that “new” animals continue to be sighted as field efforts continue. There appears to be movement of new animals into the area both within a field season and

between seasons, suggesting a higher rate of turnover of beaked whales in TOTO than previously thought. Further detailed analyses will determine the rate of individual turnover (immigration and emigration) in TOTO.



**Figure 4. Rate of discovery graph for Blainville's beaked whales in the Tongue of the Ocean shows a continued increase in the number of "new" whales identified. The photo-identification effort began in 2005 and the beginning of each annual thereafter is shown on the graph by the dashed vertical lines. "New" whales are found both within and between these annual field seasons.**

Although the majority of animals have only been seen in one year, some individuals have been seen in multiple years, suggesting possible long-term site fidelity to Tongue of the Ocean (Figure 5). Long-term site fidelity has been noted previously for this species, off Abaco Island (Claridge 2006) and off the island of Hawai'i (McSweeney *et al.* 2007).



**Figure 5. The number of years that individual Blainville's beaked whales have been sighted in Tongue of the Ocean. Although the majority of whales have only been seen in one year, 15 whales have been seen in multiple years.**



One of the whales that was resighted during BRS-08 was Md540, an adult female which was the targeted animal for the playback during BRS-07, demonstrating that this animal has remained in the area post-playback (Figure 6). The playback whale this year was a subadult male, and had not been previously sighted in TOTO.



***Figure 6. Identification photographs of an adult female Blainville's beaked whale (Md540) which was the whale targeted for the playback experiment during BRS-07 on 2 Sept 07 (photo on left).***

***This whale was seen again on 27 Sept 08 (photo on right). The arrows show the pattern of intraspecific linear scars and oval cookie cutter shark scars that are unique to Md540, and despite increased scarring which occurred between the two dates shown, the resighting of this whale on the Weapons Ranges one year after the playback can be confirmed.***

Photographic data was collected for five additional species found on the AUTC Weapons Ranges during BRS-08 and has provided some preliminary insight into their short-term residency patterns. Four different groups of short-finned pilot whales were found, and one group was resighted 4 days after the initial sighting. Fortunately, this group included the animal that was tagged and subsequently lost, and during the second sighting we were able to find the tagged whale and confirm that the tag was no longer attached to the whale. Further analysis is needed to compare groups photographed during BRS-08 with previous years to assess longer term residency to TOTO.

Individual photo-identifications taken of a group of false killer whales allowed us to confirm that this group of 13 animals remained on the Weapons Ranges for at least 3 days. Notably, this represents the first record of occurrence for this species in TOTO (the only other record for the Bahamas is of an emaciated animal seen on Little Bahama Bank).

Other species that were photographed but only seen once during BRS-08 include pan-tropical spotted dolphins, sperm whales, and melon-headed whales. Individual identifications will be compared with the photographic catalogue compiled by the BMMRO for TOTO and elsewhere in the Bahamas. Initial matching efforts have found a resighting of one sperm whale (Pm128) which has been photo-identified five times previously since 2004 off Abaco Island and the Berry Islands in Northwest Providence Channel.

## **IMPACT/APPLICATIONS**

Mass strandings of beaked whales in several areas (e.g. Simmonds and Lopez-Juraco 1991, Frantzis 1998, Jepson *et al.* 2003), including the northern Bahamas (Balcomb and Claridge 2001, Evans and England 2001) have correlated with international naval operations, raising concern that beaked whales are particularly vulnerable to anthropogenic noise. Findings during the Behavior Response Study will help to address these concerns in numerous ways. The primary goal of exposing beaked whales, pilot



whales and other “blackfish” to varying types of signals, including MFA sonar, killer whale calls and pseudo-random noise during playback experiments to determine their response was successfully completed during BRS-08, although it is still necessary to repeat the experiment to a larger number of beaked whales, and also other beaked whale species. In addition, during BRS-08 we have also gathered important baseline data on species occurrence and residency patterns of beaked whales and other species on the AUTECH-Andros Operating Area which will help assess current mitigation on the range and contribute much needed data for environmental reviews.

Whales inhabiting the Weapons Ranges at AUTECH are exposed to various military sonars on a regular basis, including two 53C MFA sonar exercises annually during the Commander’s Conference at AUTECH and it is important that the Navy ensure that their current mitigation is effective. The photo-identification data collected during two years of the Behavior Response Study suggests that some Blainville’s beaked whales are resident to the AUTECH-Andros Operating Area and may display long-term site fidelity. However, there appears to also be some turnover of new animals into the area on a regular basis. The implication of this finding is that what was once thought to be a “habituated” population may actually include animals that spend very little time in TOTO. Planned detailed analysis of the photographic data will allow us to estimate abundance and rates of immigration and emigration of Blainville’s beaked whales in TOTO to more thoroughly examine residency patterns and site fidelity. The photographic data and tissue samples collected during BRS will also contribute to a population structuring study currently being conducted on a larger scale, in the Great Bahama Canyon (TOTO forms the southern branch of this submarine canyon) to assess the relationship of beaked whales in TOTO to stocks identified elsewhere in the northern Bahamas.

## **RELATED PROJECTS**

### **Behavior Response Study (BRS)**

The goal of this project is to understand how cetaceans respond to underwater sound. This international study is led by Dr. Ian Boyd (SMRU) as the Chief Scientist and holder of Bahamian research permit, and the Principal Investigator and holder of US permit was Dr. Brandon Southall (National Oceanographic and Atmospheric Administration (NOAA)). The project is supported by the Office of Naval Research (ONR) and US Department of Defense (NAVSEA PEO IWS Mr. Joseph Johnson and OPNAV N45 Dr. Frank Stone).

Distribution, abundance and population structuring of beaked whales in the Great Bahama Canyon, northern Bahamas

The goals of this project are to determine beaked whale distribution and abundance in the Great Bahama Canyon (Northeast and Northwest Providence Channels and Tongue of the Ocean) from visual and acoustic surveys. The study is examining population structure of beaked whales in the Great Bahama Canyon through the analysis of photo-identification data and genetic samples archived by BMMRO and from photographs and biopsy samples obtained during the surveys. The project is funded by an ONR grant (FY07 – FY10) and Diane Claridge (BMMRO) is the Principal Investigator and Dr. John Durban (NOAA) is the co-Principal Investigator. Dr. Jonathan Gordon (SMRU) oversees the acoustic surveys with funding from the UK’s Defense Science and Technology Laboratory.

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